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Supply and demand in Kaldorian growth models: a proposal for dynamic adjustment

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Abstract

This paper analyses the dynamic adjustment of supply and demand in Kaldorian growth models. We aim at discussing how the growth rate of a country, given by demand constraints, adjust towards the growth rate given by the supply-side, and vice-versa, presenting the necessary conditions for those adjustments. Our main conclusion is that if there are no capital constraints, firms invest to maintain a constant desired level of capital utilization. Depending on specific conditions, however, an economy may face labour constraints, which would require an adjustment mechanism on employment. The Palley-Setterfield approach brings a possible reconciliation to supply- and demand- long-term growth rates. However, we must raise some considerations about the labour market in order to understand the characteristics of this approach. We draw from the critique by McCombie, in which employment adjusts immediately to guarantee equilibrium between supply and demand. We propose reconciliation between the Palley-Setterfield and the McCombie approaches, presenting a model focused in a labour market adjustment, in which both types of adjustments represent extreme cases, discussing the existence and the characteristics of intermediate cases.

Keywords: economic adjustment, demand-led growth, natural rate of growth, Kaldorian growth models

JEL: E12; F43; O41.

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1. Introduction

A central concern on economic theory regards why countries growth rate diverge in the long-run, why are some countries capable of catching-up while others not. Endogenous and neoclassical growth theories (Romer, 1994; Solow, 1956) assert that the explanations for the differences between countries' growth rates are related to availability of factors and their allocation, which characterises a supply-oriented approach. On the other hand, the Post-Keynesian perspectives (Blecker & Setterfield, 2019) emphasise the relevance of effective demand as a primary drive of accumulation, and thus the long-run growth rate is demand-driven.

The Harrod-Domar model was the first macroeconomic model that explicitly provided a theory for economic growth. It focused on defining the investment and saving growth rates capable of maintaining a growing economy in equilibrium - analysing the determinants of the divergence between supply and demand. This canonical model, however, could not offer an explicit adjustment mechanism for this divergence. The problem of Harrodian instability resulted in the emergence of distinct traditions trying to answer this question (demand-oriented models developed by Keynesian economist, as well as on the supply-oriented models developed by neoclassical economists).

In the neoclassical models, countries' long term growth were explained by the supply factors (rate of growth of population and labour productivity), as demand automatically adjusts to supply via Say's law. Post-Keynesian growth models (Blecker & Setterfield, 2019; Harcourt & Kriesler, 2013), on the other hand, relying on the effective demand theory, have stressed the central role of demand on explaining the differences between countries' growth rates. According to Kaldor (1966), although some changes in demand have their origin on changes in supply, the prominence is on the demand side, and it is mainly supply that adjusts to demand. Countries' growth rates are then primarily governed by the growth of effective demand, and not resource constraints.

The literature is imbued with many controversies regarding the adjustments between supply and demand. From a production perspective, a faster growth rate of demand increases productivity (via Verdoorn's law), which increases the natural rate of growth at a specific rate. From the Post-Keynesian perspective, growth is constrained by demand, and its growth rate may be different from the natural rate. In the long-run, however, those growth rates need to converge in order to avoid an ever-growing excess of capacity. Three-quarters of century since Harrod first published his paper on the dynamics of supply and demand, there is still no consensus on the central drivers of economic growth.

The aim of this paper is to analyse this dynamic adjustment of supply and demand based on Kaldorian supply and demand models, using the recent literature published on this topic (Blecker, 2013; McCombie, 2011; Palley, 2003; Setterfield, 2006, 2011, 2013). Our aim is to discuss the adjustment process between supply and demand growth rates, presenting the necessary conditions for this adjustment, considering stable employment and capacity utilization. Our main conclusion is that, for a monopolistic economy, where firms invest to maintain a constant level of capital utilization, capital constraints is not a problem, and thus the degree of capacity utilization does not change in the long run. However, depending on specific conditions, an economy may face labour constraints, and thus we need an adjustment mechanism in the labour market. The Palley-Setterfield approach brings a possible solution to this problem. We argue, however, that this mechanism depends on some considerations about labour supply, starting from the critique by McCombie (2011).

The contribution of this paper is twofold: first, to organize the recent literature on the adjustments between supply and demand Kaldordian models in a unified framework. We explicitly model the behaviour of labour supply and labour demand in the adjustment, as the determinants of a stable employment dynamics. Second, we propose the introduction of a simple general model, that not only deals with the different streams of the debate (Palley-Setterfield and McCombie), but also represent a possible intermediate adjustment, defining different possible adjustments, and steady stave values, for supply and demand.

The paper is divided in five sections. After this introduction, Section 2 presents the macro-dynamics of supply and demand adjustments based on the Palley-Setterfield controversy (Palley, 2003; Setterfield, 2006), and on McCombie's (2011) critique. Section 3 presents Setterfield (2013) argument for the need of a supply-side of Kaldorian growth models, highlighting the importance of capital and labour constraints. Section 4 presents our contribution for an alternative approach for the adjustment mechanisms based on Setterfield's (2013) argument, as well as the necessary conditions a reconciliation of supply and demand. Finally, we conclude the paper on Section 5.

2. The macro-dynamics of supply and demand

The Kaldorian framework starts from an explicit discussion on the behaviour of supply and demand growth rates. In this section we present (1) the canonical Kaldorian model as discussed in Setterfield (2006), and (2) the adjustment mechanisms proposed in the literature.

The supply side is given by the natural growth rate, which accounts for by the growth of the labour force and the growth of labour productivity. However, different from Harrold's version, this rate of growth, from a Kaldorian perspective, is endogenous to output growth once productivity is determined by output growth based on the Kaldor-Verdoorn law:

$$y_N = l + q = l + \lambda + vy \tag{2.1}$$

where y_N and y are, respectively, the natural and actual growth rates, l is the labour force growth rate, and q is the growth rate of productivity. Productivity follows the Kaldor-Verdoorn law, in which λ is the exogenous technical change, and v is the Verdoorn's coefficient (the sensibility of productivity growth to actual growth rate).

Following Palley (2003), we assume that demand will be constrained by the rate of growth compatible with stability in the balance of payments. From the Balance-of-Payment Constrained

Growth (BPCG) model, we have that the demand rate, that defines the actual growth rate, is given by Thirlwall's law (Thirlwall, 1979)[3]:

$$y = y_B = \frac{\varepsilon}{\pi} z \tag{2.2}$$

where y_B is the BPCG rate, ε and π are the income elasticities of demand for exports and imports, respectively, and z is the world growth rate.

Following the Harrod instability problem, we do not have an explicit convergence mechanism for the equilibrium between supply and demand ($y_N = y_B$), as the model is over-determined. Given the world growth, the income elasticities, the Verdoorn coefficient, the exogenous technological change and the labour force growth, the only way to supply and demand to converge is when:

$$\frac{l + \lambda}{1 - v} = \frac{\varepsilon}{\pi} z \tag{2.3}$$

but there is no reason to believe that all this exogenous variables assumes exactly these values.

In order to solve the over-determination, Palley (2003) adds an extra equation, arguing that the income elasticity of demand for imports is negatively related to the excess of capacity utilization. "imports are driven by bottlenecks" (p. 80)[4]. Hence:

$$\pi = \pi(E), \pi' > 0 \tag{2.4}$$

where E is defined as the degree of capacity utilization (labour- or capital- utilization).

The natural growth rate affects the income elasticities of demand, and thus the Balance of Payments constrained growth rate responds passively to changes in the natural rate of growth. In Palley's adjustment, the growth rate of the economy is determined by the natural rate[5], which characterises a *quasi-supply-determined growth*.

With the idea of offering an alternative approach, Setterfield (2006) provides another mechanism (closure) to solve Palley's over-determination problem. Setterfield (2006) argues that

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[3] Although the effective growth rate should be given by the sum of the aggregate demand macroeconomic variables, following Palley (2003) and Setterfield (2006, 2011), we use the Thirlwall's law equation as the actual growth rate. The actual growth rate needs to converge to the one compatible with balance-of-payments constraints, otherwise the economy goes out of bounds in terms of its net exports - see Porcile & Spinola (2018).

[4] Evidence for the Palley mechanism can be found since White and Thirlwall (1974).

[5] Palley's adjustment is in a way similar to Krugman's (1989) approach to the relationship between total factor productivity and income elasticities. Krugman argues that the 45-degree rule (which nothing else than Thirlwall's law)[5] is explained by the growth of total factor productivity, which is strictly related to the specialization in trade.

productivity growth is a positive function of the degree of utilisation (Verdoorn's law). The natural growth rate is then endogenous to actual growth rate:

$$v = v(E), v' > 0 \tag{2.5}$$

The *rationale* is the following: learning by doing processes result that the rate of economic activity induces productivity growth, affecting the Verdoorn's coefficient (v). If the level of demand is low relative to the full capacity utilization, then firms will be less likely to engage in technical change, reducing productivity gains. In Setterfield (2006)'s adjustment, the economy has a *fully-demand-determined growth* pattern.

Palley (2003) and Setterfield (2006) rely on the idea that short-run effects may affect, respectively, the income elasticities and the Verdoorn coefficient. McCombie (2011), however, criticizes both approaches. In his perspective, short-run income elasticities may change due to short-run cyclical effect, but they are constant stable structural variables in the long-run. The increase of imports raise the potential output, so the degree of capacity utilization returns to its original level. Consequently, the long-run income elasticities of demand for imports do not change. Furthermore, McCombie (2011) argues that the growth rates of labour force (l) and technical change (λ) are also endogenous to the rate of capacity utilization (E), which results that there is no unique rate of growth associated with a stable rate of unemployment. Growth rate is then always balance-of-payment constrained (demand-determined) even if the Verdoorn's coefficient is not endogenous.

$$l'(E) > 0, \lambda'(E) > 0 \tag{2.6}$$

Based on Cornwall (1977), McCombie (2011) argues that even mature economies have an elastic labour force, and technical progress is stimulated by the increase in the degree of capacity utilization due to a great number of factors, such as an increase of R&D expenses and investments in more productive capital. Thereby, he argues that countries are not usually supply constrained, but only balance-of-payment constrained.

By considering that the natural growth rate curve is then vertical, in which "there is no unique rate of growth associated with a constant rate of unemployment", y has an infinite elasticity in relation to E. Consequently, in McCombie (2011)'s case, growth rates are determined only by the demand side, once there are multiples natural growth rates associated with a unique degree of capacity utilization. The BPCG rate determines the growth rate in the long run and the natural growth of rate adjusts towards this rate through labour supply adjustments (i.e. Migration between sectors of a dual economy, or international migration of workers). If a country starts growing faster without experiencing a structural change on its BPCG rate, the economy will tend to the steady state E^* and, consequently, to the original BPCG rate.

In other words, if labour force and technological change are endogenous to the degree of capacity utilization, the supply side does not constraint growth (completely accommodated by demand shocks), and thus the economy is demand-driven. Furthermore, different from the

Setterfield's (2006) scenario, the degree of capacity utilization does not change – compatible with the hypothesis that there is a natural rate of capacity utilization to which the economy tends to fluctuate around. Some studies, such as León-Ledesma & Lanzafame (2010), and Lanzafame (2014), have investigated the relationship between the BPCG and the natural growth rates, and found unidirectional causality from the BPCG rate to the natural growth rate. There are many studies showing the endogeneity of the natural rate: León-Ledesma & Thirlwall (2012); Vogel (2009) and Libâlenio (2009) for Latin America; Dray and Thirlwall (2011) for Asia.

3. Capital and labour constraints: necessary conditions for reconciliation

In another step of the debate, Setterfield (2013) argues that McCombie (2011)'s critique to the Palley-Setterfield approach is based on the assumption that actual rate of growth is always bellow its potential, being unconstrained by capital or by labour. That, however, only happens under very specific conditions. In order to explain those conditions, Setterfield (2013) uses an explicit description of the supply side. First, the potential growth rate is given by a Leontief production function[6]:

$$Y_P = \min\left[\frac{L_c}{a}, \frac{K_c}{b}\right] \tag{3.1}$$

where Y_P is the potential growth rate, L_c is the labour available, K_c is the capital available, a is the potential labour output ratio, and b is the potential capital-output ratio.

In this type of production functions, two possible constraints emerge. First, a labour constraint, if the actual rate of growth is higher than the growth rate of $\frac{L_c}{a}$. Second, a capital constraint, if the economy grows faster than $\frac{K_c}{b}$.

Labour constrained economy

The labour constraints is described from the first part of Leontief function (3.1). In growth rates:

$$Y_P = \frac{L_c}{a} \rightarrow y_P = n - \hat{a} \tag{3.2}$$

Two channels in which the actual growth rates affect y_P can be observed. First, the abovementioned Verdoorn's law:

[6] See Setterfield (2013) for the arguments in favour of adopting a Leontief function to describe the supply side.

$$-\hat{a} \equiv q = \lambda + \nu\, y \tag{3.3}$$

in which $\hat{a}$ is the growth of labour-output ratio.

Second, the total available labour force (n) is endogenous to the output growth, such as argued by McCombie (2011):

$$n = \gamma + \delta y \tag{3.4}$$

where γ is the exogenous growth of labour, and δ is the labour-elasticity to output.

Hence, growth rate of potential output can be written as the sum of a linear function of exogenous technical change-labour force growth, and endogenous technical change-labour force growth:

$$y_P = \gamma + \lambda + (\delta + \nu)y \tag{3.5}$$

The impact of an increase of the actual rate of growth (which is given by the demand side) impacts the labour side of potential growth rate as follows:

$$\frac{d(y_P)}{d(y)} = \delta + \nu \tag{3.6}$$

Based on this relationship, Setterfield (2013) concludes that there is only one specific case in which the economy does not face a labour constraint: $\delta + \nu = 1$. In this case, y_P and y grow at the same rate not only in the long run, but also in the short run. Thereby, the economy does not present variations in the degree of capacity utilization, and there is no need for reconciliation. However, if $\delta + \nu < 1$, then the economy faces labour constraints, which requires a reconciliation between supply and demand.

Capital constrained economy

Setterfield (2013) also presents the necessary conditions for having a capital constraint in the economy:

$$Y_P = \frac{K_c}{b} \rightarrow y_P = \widehat{K_c} - \hat{b} \tag{3.7}$$

According to Kaldor (1961), the capital-output ratio (b) is constant in the long run. Consequently, there is only one possible response for a faster growth in y_P, which is a faster growth of capital accumulation. Hence, potential output growth rate can be described as:

$$y_P = \widehat{K_c} \tag{3.8}$$

Setterfield (2013) adds an investment function based on a simple accelerator mechanism:

$$\Delta K_c = I = b\,\Delta Y = byY \tag{3.9}$$

There is no depreciation, and thus growth of capital equals investment. Moreover, given a constant capital-output ratio, investment is determined uniquely by the growth of output, and hence we have:

$$b = \frac{K_u}{Y} = \frac{K_c}{Y_P} \tag{3.10}$$

and

$$u = \frac{Y}{Y_P} = \frac{K_u}{K_c} \tag{3.11}$$

where u is the degree of capital capacity utilization, and K_u the capital employed.

The rate of growth of potential product can be written as:

$$y_P = \widehat{K_c} = \frac{\Delta K_c}{K_c} = b\,y\frac{Y}{K_c} = \frac{K_u}{Y}y\frac{Y}{K_c} = u\,y \tag{3.12}$$

Analogous to the analysis of labour constraints, the impact of a faster growth of the actual rate of growth on the growth rate of potential output is:

$$\frac{d(y_P)}{d(y)} = u \Rightarrow d(y_P) = u\,d(y) \tag{3.13}$$

The only way potential and actual outputs grow at the same rate is when $u = 1$, which is a specific and heroic assumption. Thereby, based on capital and labour constraints, the demand side is fully accommodated by the supply side only under the very specific case where $u = 1$ and $(\delta + v) = 1$. Consequently the need for a reconciliation between supply and demand based on Palley-Setterfield mechanisms re-emerges.

3.1. Capital constraints in monopolistic economies

In a monopolistic economy, capitalists aim to keep the degree of capital utilization unchanged[7]. This behaviour leads the growth rate of Y_P being equal to the growth rate of demand, a situation in which there are no capital constraints. In a more detailed explanation, based on the assumption that b is constant (Kaldor, 1961) and that there is no depreciation:

$$I = \Delta K_c = b\,\Delta Y_P \tag{3.14}$$

Once $u = \frac{Y}{Y_P}$, we can write investment in terms of capacity utilization:

$$I = b\left(Y_P - Y_{P_{-1}}\right) = b\left(\frac{Y}{u} - \frac{Y_{-1}}{u_{-1}}\right) \tag{3.15}$$

Investment here is a function of output, as stressed by Setterfield (2013), but also of the degree of capacity utilization, as we assume that capitalists invest to keep the degree of capacity utilization unchanged. The investment function can then be written as[8]:

$$\Delta K_c = I = \ b\,\frac{\Delta Y}{u} = \frac{b}{u}yY \tag{3.16}$$

This equation is very similar to Setterfield's (2013) accelerator mechanism, but the degree of capacity utilization keeps unchanged. The growth of potential output is given by:

$$y_P = \widehat{K_c} = \frac{\Delta K_c}{K_c} = \frac{v}{u}y\frac{Y}{K_c} = \frac{K_u yY}{uYK_c} = y \tag{3.17}$$

which means that $d(y_P)$= $d(y)$.

[7] Empirical evidences, as presented in Caiani et al. (2016), show that firms aim for normal rates of utilization. Moreover, excess capacity works as an entry barrier strategy against new firms. Lavoie (2014) offers a survey on the topic.

[8] It does not mean that capacity utilization keeps unchanged. The assumption is that investment is made trying to keep it unchanged. However, it may vary due to many factors, including a faster demand growth or investors' difficulties to find funding for their investment.

Thereby, when investment is oriented to keep the degree of capacity utilization unchanged, there is no capital constraint[9]. The previous result was a result of the sole static accelerator mechanism. Once we assume that investment is a function both of demand growth and the degree of capacity utilization, the supply side will be fully accommodated by the demand side even if $u < 1$.

4. General model: a reconciliation

An investment function that responds to capacity utilization lead to no capital constraints. In a monopolistic economy, capital supply is *fully*-endogenous to demand growth (when we do not have funding constraints), and all demand for capital is fulfilled by its supply. Thereby, there are no capital constrains. Nevertheless, labour constraints may still emerge, and one need to present a reconciliation between supply and demand.

In order to address the reconciliation between growth rates under labour constraints, we propose a review of the debate. We then propose a general model addressing all the contributions (Palley's (2003), Setterfield's (2006), McCombie's (2011), and Setterfield (2013)). Our central interpretation is that the McCombie's (2011) critique is, in its core, not about the hypothesis that income-elasticity of demand for imports or Verdoorn's coefficient respond to the rate of capacity utilization. Instead, it is on how Palley (2003) and Setterfield (2006) do not address some specific factors that respond to actual output growth in the labour market.

We start our revision of the theory by writing the basic equations of the Kaldorian model considering the Palley and Setterfield mechanisms (π and v). In our formulation we implement linear representations for $\pi = \pi(E)$ and $v = v(E)$, for the sake of simplification:

$$y_B = \frac{\varepsilon}{\pi_0 + \pi_1 E} z \tag{4.1}$$

$$y_N = n + \lambda + (v_0 + v_1 E) y \tag{4.2}$$

where π_0 is the exogenous component of the income-elasticity of demand for imports, π_1 is the sensitivity of the income-elasticity of demand for imports to the capacity utilization (Palley-effect), E is employment, v_0 is the exogenous component of the Verdoorn coefficient, v_1 is the sensitivity of the Verdoorn coefficient to the capacity utilization (Setterfield effect).

Before introducing McCombie's (2011) critique to these models, we define the rate of capacity utilization. Since we are only dealing with labour constraints, we define it as the degree of labour utilization – given by the employment rate (E). Now we explore the labour market

[9] We are not neglecting here that capital constraints will never emerge. Countries can have funding problems both domestically and internationally. However, these capital constraints do not emerge from Setterfield's (2013) critique if firms invest to maintain a constant level of capital utilization.

dynamics, in which the employment rate (E) is given by the ratio of effectively absorbed labour (L) and the supply of labour (N).

$$E = \frac{L}{N} \tag{4.3}$$

or, in terms of growth rates,

$$e = l - n \tag{4.3b}$$

Where the lower cases represent the growth rates.

Equation (4.3b) defines the dynamic adjustment of supply and demand. Rather than using the approach presented in Section 2, which is based on the relation between E and y, in this section we analyse the dynamics of e. The lack of adjustment of the supply of labour to the labour force effectively employed explains the dynamic adjustment of supply and demand.

4.1. Revisiting the Palley-Setterfield debate in light of the Labour market

As presented in the previous section, we derive the employment rate growth (e) from the growth of labour supply (n) and the growth of labour force effectively employed (l). The labour market adjustment is a necessary condition for a stable employment dynamics, and for the convergence between supply and demand growth rates.

For both Palley (2003) and Setterfield (2006) it is implicit that the supply of labour is not sensitive to the rate of capacity utilization. That is the case in which most advanced economies find themselves, given that there is no duality *à la* Lewis (1954). In developing economies, however, traditional sectors act as a reservoir of labour force for the more productive sectors, and hence these advanced sectors face a perfectly elastic supply labour force (McCombie and Thirlwall, 1994). As countries reach most advanced stages of development, the surplus labour from traditional sectors is exhausted, and the supply of labour moves toward a more inelastic pattern.

Following this idea, we first consider a full inelasticity hypothesis, in which the labour supply (n) is constant, given by an exogenous component (n_0) (exogenous population growth):

$$n = n_0 \tag{4.4}$$

We first examine the dynamics of the effectively employment of labour (l). The higher is the actual growth rate (y), the more it demands labour, increasing the growth rate of labour effectively employed. Given that productivity is endogenous to output growth, it also increases the natural rate of growth (y_n), which reduces the demand for labour (given productivity gains), reducing the growth rate of effectively employed labour. In summary, the growth rate of the labour force effectively employed is given by:

$$l = \phi(y - y_N) + n \quad (4.5)$$

ϕ is the speed of the adjustment mechanism.

As McCombie (2011) highlights, the identity in which $p = y - l$, where p is the productivity growth, must be valid, since productivity is defined as the output-labour ratio. Reorganizing it, we observe that actual growth rate (y) is given by productivity growth (p) and/or by employment growth (l). In order to have this identity ($y = p + l$), ϕ must be equal to one.[10] Replacing equation (4.2) in (4.5a), and considering that $\phi = 1$:

$$l = -\lambda + (1 - v_0 - v_1 E)y \quad (4.5b)$$

Equations (4.4) and (4.5b) provide the system that gives the adjustments of the model, determining the growth of the employment rate (e). We assume that the long-term demand growth provides a good approximation for the actual output growth ($y_B = y$). In this sense, equations (4.1), (4.2), (4.3b), (4.4) and (4.5b) are enough to solve the Palley-Setterfield version of our model.

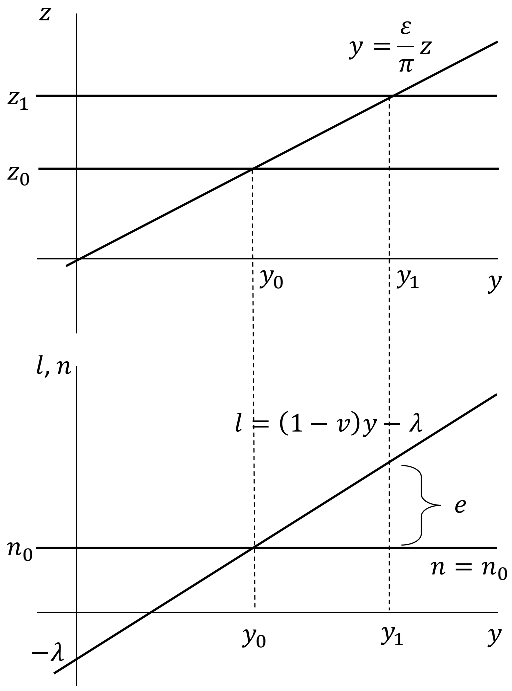
Figure 4.1 presents two graphs. The upper one shows the demand (and effective) growth rate, given by the BPCG. Given z and the elasticities ratio, we determine y, following Thirlwall's law. The lower graph shows l, n as a function of y, and the difference between l and n gives us e. In this case, the supply of labour is entirely inelastic to y ($n = n_0$), and hence it is a horizontal line. It means that variations in the actual growth rate do not affect the labour supply since it is exogenously given. Labour effectively employed, on the other hand, is positively related to output growth[11].

When the world output growth (z) is given by z_0, the economy finds itself in equilibrium, since labour effectively employed is equal to labour supply ($l = n$), resulting in $e = 0$ (stable employment). In this case, the growth rate of the economy (y_0), given by the elasticities ratio and the world growth, is the one that guarantees that labour supply and labour effectively employed in the economy grow at the same rate. This situation is the one presented in Equation (2.3), where the exogenous variables of the over-determined system of equations assumes the exact value needed for the stability.

[10] Replacing $p = y - l$ in the natural rate of growth we have that $y - y_N = \phi(y - y_N)$. This equation has two possible solutions: $y = y_N$ and $\phi = 1$. If y is not necessarily equals to y_N, as we are supposing, ϕ must be equal to one.

[11] If Verdoorn coefficient is lower than one ($v < 1$).

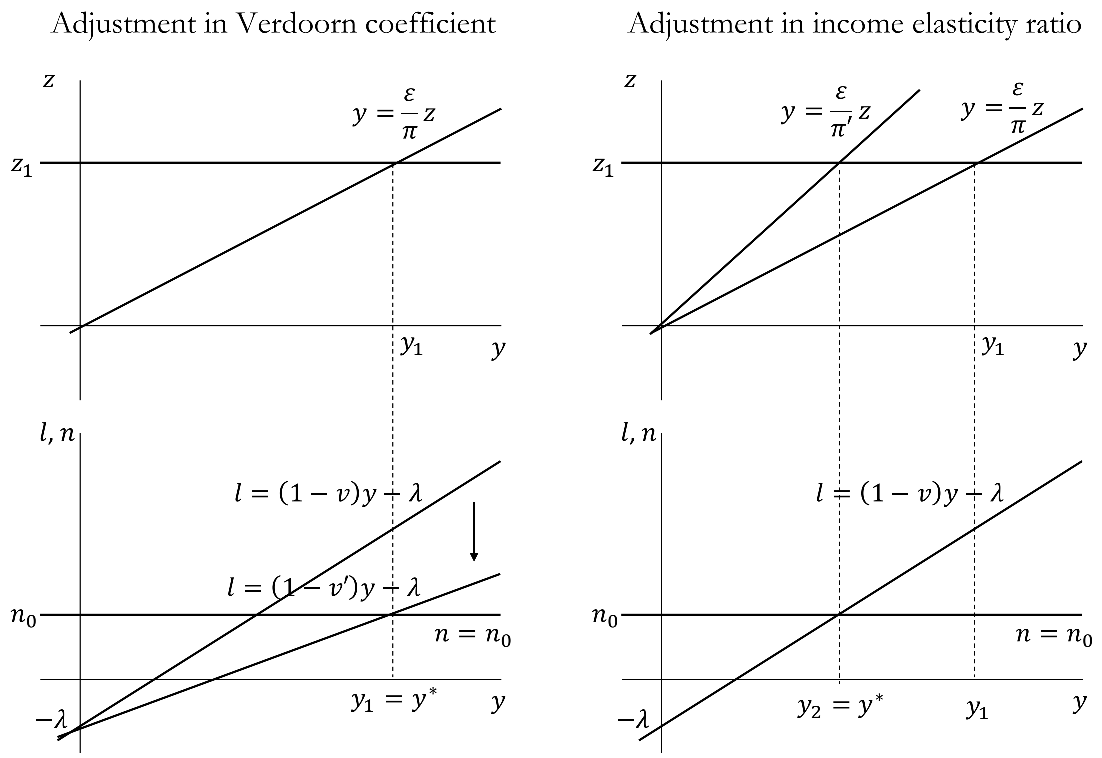
Figure 4.1 – Labour supply and effectively employed in the Palley-Setterfield case (short run)



However, as one can see in Figure 4.1, an adjustment is necessary whenever the world output growth is different than z_0. If the economy finds itself in a position in which $z_1 > z_0$, the actual growth rate will increase (due to Thirlwall's law), and hence the growth of labour force effectively employed will be higher than the growth of labour supply. Since initially nothing guarantees that $-\lambda + (1 - v)y = n_0$, the natural and the actual growth rates will differ, which may lead to instability. Employment rate (E) changes in time since there is a gap between labour effectively employed and labour supply, once e is positive, as $l > n$.

Based on the Palley-Setterfield adjustment mechanisms, when $e \neq 0$, the Verdoorn coefficient and/or the income-elasticity of demand for imports change. As can be seen from Figure 4.2, these movements serve as adjustment mechanisms, changing the actual growth rate (y).

Figure 4.2 – Adjustment of labour supply and effectively employed in the Palley-Setterfield case



The cases presented in Figure 4.2 are those proposed by Setterfield (2006) (left part) and Palley (2003) (right part of the figure). In the Setterfield adjustment, when $e > 0$, the employment rate increases, and the Verdoorn coefficient grows from v to v'. The curve of the labour effectively employed labour growth rotates clockwise, resulting in a new equilibrium, with higher actual growth rate. In this case, demand fully accommodates supply, and the growth rate of an economy is *fully-demand determined.*

In the Palley case, when $e > 0$, the income-elasticity of demand for imports increases from π to π'. Here, there is no change in the effective labour growth curve. Instead, the actual growth rate reduces towards a new equilibrium (the elasticities ratio curve will move anti-clockwise). In this case, supply fully accommodates demand, and hence the growth rate of an economy is *fully-supply determined.*

With the aim of analysing the stability conditions we first replace (4.4) and (4.5b) in (4.3b). By considering that $y_B = y$, we have:

$$e = (1 - v_0 - v_1 E)\frac{\varepsilon}{\pi_0 + \pi_1 E} - (\lambda + n_0) \tag{4.6}$$

For the model to be stable, E cannot explode, and hence we must have $\frac{de}{dE} < 0$, which implies:

$$\frac{de}{dE} = \frac{-v_1(\pi_0 + \pi_1 E) - \pi_1(1 - v_0 - v_1 E)}{(\pi_0 + \pi_1 E)^2(1+\theta)} \leq 0 \tag{4.7}$$

Once one can expect that the income elasticity of demand for imports $(\pi = \pi_0 + \pi_1 E)$ is positive, and the Verdoorn coefficient $(v = v_0 + v_1 E)$ is lower than one, the only required stability conditions are $v_1 \geq 0$ and $\pi_1 \geq 0$.

A stable long run ($e = 0$) results in the following steady state:

$$E^* = \frac{(1 - v_0)\varepsilon z - \pi_0(\lambda + n_0)}{v_1 \varepsilon z + \pi_1(\lambda + n_0)} \tag{4.8}$$

4.2. Revisiting the McCombie adjustment

According to McCombie (2011), the Palley-Setterfield (Palley, 2003; Setterfield, 2006) adjustment ignores that both labour supply and technological progress are endogenous to the rate of capacity utilization, and hence to the actual output growth. Cornwall (1977) argues that, even in advanced economies, the supply of labour may be elastic to wage and output growth. Although Lewis' view on labour surplus is concerned with less advanced countries, Cornwall (1977) argue that "employment patterns were demand determined in the various market economies in the post-war period", and "when entrepreneurs in the manufacturing sectors of different economies wanted labour they found it one way or another" (p.95). Thereby he argues that the supply of labour is endogenous to output growth.

McCombie (2011) argues that technical progress is stimulated by the increase in the degree of capacity utilization due to a great number of factors, such as an increase of R&D expenses and investments in more productive capital. However, as the Verdoorn coefficient is already considering the impacts output growth on technological change,[12] we focus entirely on the impact of actual output growth on labour supply.

We now assume that the supply of labour responds to output growth, guaranteeing that the natural rate of growth will not differ, not even in the short-term. This assumption implies that $y_N = y$, and that the adjustment is entirely done on the growth rate of labour supply (n). Considering that the identity $p = y - l$ is valid, and that the productivity is given by Verdoorn's law, $p = \lambda + vy$, we replace equation (4.1) in this identity. Considering that $y_N = y$, then:

$$n = l \tag{4.9}$$

[12] It is possible to consider it more precisely by including a term in the productivity that accounts for deviation from capacity utilization, $p = \lambda + vy + c(y - y_N)$. It is important to avoid that rather than measuring the Verdoorn coefficient, we could be measuring Okun's law (Magacho & McCombie, 2017). However, for simplicity we will ignore it here.

Labour supply adjusts completely to the labour demand, guaranteeing automatic (and immediate) convergence between the natural rate of growth and the actual output growth. Labour supply growth always coincides with the labour effectively employed labour growth schedule. It implies no gap between labour supply and employment, maintaining the employment rate constant.

Once the natural rate of growth is defined by (4.1), and the actual output growth is defined by the BPCG rate, which is given by (4.2), then we have that always $y_B = y = y_N$. Labour supply is thus given by:

$$n = (1 - v)\frac{\varepsilon}{\pi} z - \lambda \tag{4.10}$$

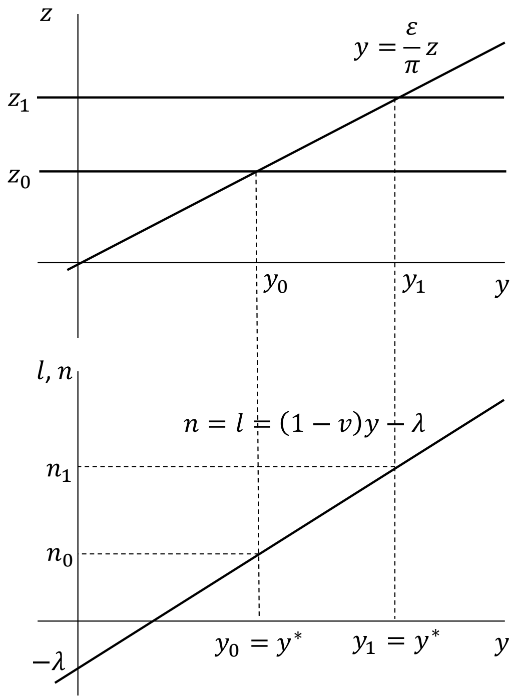
where π and v are constant since e is always equal to zero, and hence $E = E^*$.

Since E is fixed, the model is always stable. In order to calculate the value of E^*, we can recall equation (4.6), assuming equation (4.9) ($n = l$). As $e = 0$, then:

$$E^* = \frac{(1 - v_0)\varepsilon - \pi_0(\lambda + l)}{v_1\varepsilon + \pi_1(\lambda + l)} \tag{4.11}$$

In graphical terms, the labour supply growth curve coincides with the labour effectively employed growth curve. In Figure 4.3 we see that the economy is always in equilibrium (immediate adjustment, as the natural and actual growth rates do not diverge). In this case, again, supply accommodates to demand, and the growth rate of an economy is *fully-demand determined*.

Figure 4.3 – Adjustment when labour supply is completely endogenous to demand



4.3. General reconciliation proposal

Although the results of the adjustments presented in the previous sections are structurally different – in McCombie's approach it is always the natural growth rate that adjusts towards the BPCG rate, whilst in Palley-Setterfield approach both results are possible – the models are very similar in terms of their required equations. The main difference is in the determination of labour supply (n) which is endogenous to McCombie (2011) and exogenous to Palley (2003) and Setterfield (2006). Equations (4.1), (4.2), (4.3b) and (3.5b) are valid in both views. Thereby, for the reconciliation, we define an equation for labour supply that encompasses the different approaches.

If one assumes that income-elasticity of labour supply is linear, such as in Setterfield (2013) debate, both approaches can be summarized by equation (4.12):

$$n = \gamma + \delta y \tag{4.12}$$

$\gamma = n(0)$ and $\delta = dn(y)/dy$.

Palley (2003) and Settefield (2006) assume that labour supply is constant and equal to n_0, which results in $n(0) = n_0$ and $dn(y)/dy = 0$. McCombie (2011), however, assumes that labour supply adjusts to labour demand, and hence $\gamma = n(0) = -\lambda$ and $\delta = dn(y)/dy = (1 - v)$. In terms of the labour supply and employment growth diagram, the discussion becomes about the intercept and the slope of the labour supply curve.

Equation (4.12)[13] replaces equations (4.4) and equation (4.9b), and γ and δ define whether the McCombie's approach or Palley-Setterfield approach are valid. Replacing (4.12), (4.3b) and (4.5b) in $\dot{E} = Ee$, given by the definition of $e = l - n$, then:

$$\dot{E} = E[(1 - v_0 - v_1 E)y - \lambda - \gamma - \delta y] \tag{4.13}$$

If one assumes that actual output growth is equal to long-term demand growth ($y = y_B$), equations (4.1) and (4.2) and (4.13) are enough to define the general model, which encompasses all different approaches. The full representation of the model is detailed in the Appendix A, including the solutions for steady state and stability. The values of δ and γ also impacts the employment equilibrium value, which is given by:

$$E^* = \frac{(1-v_0)\,\varepsilon z - \delta\varepsilon z - (\lambda+\gamma)\pi_0}{(\lambda\pi_1 + \gamma\pi_1 + v_1\varepsilon z)} \tag{4.14}$$

Equation (4.12) is interesting as it also allows us to represent intermediate cases, in which neither labour supply is exogenous, nor it is completely endogenous to its demand. The intermediate cases can on one hand be in line with evidences of endogeneity (see McCombie and Thirlwall (1994) for a discussion on that), but also it does not require a complete endogeneity, as argued by McCombie (2011).

Figure 4.4 presents both Setterfield (2006) and Palley (2003) adjustments in this intermediate case. In the left-hand case, where the Verdoorn coefficient is the adjustment variable, long-term growth rate is fully-demand determined. This adjustment is very similar to the one of Figure 4.2, but labour supply also increases to accommodate its demand, and hence the Verdoorn adjustment does not need to be as large as it was required before.

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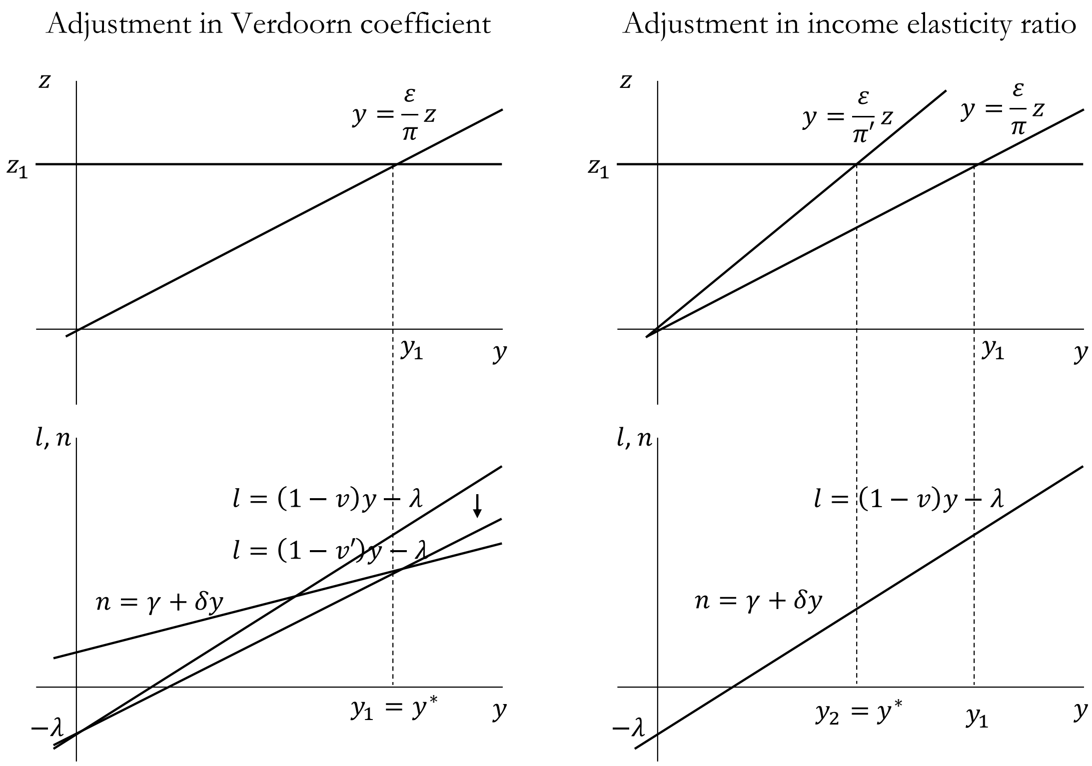
[13] It is relevant to mention that v depends on E, but in the McCombie case, as we are aware that E does not change, then $E_0 = E^*$. With that, we are able to define the value of δ for the McCombie case as $\delta = 1 - v_0 - v_1 E_0$.

Figure 4.4 – Adjustment of labour supply and effectively employed in the Palley-Setterfield case



The main difference resides in the right-hand case, where income elasticity of demand for imports is the variable of adjustment. In this case, if one assumes a demand shock (i.e. in z), a complex process emerges since demand adjusts via changes in elasticities ratio, and supply adjusts via movements in the labour market – and the labour supply will respond positively to the shock.

4.4. Dynamic adjustment in supply and demand in the general case

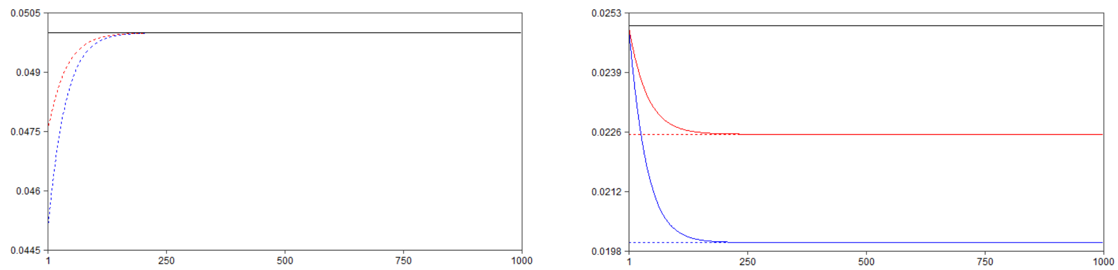
For better understanding the consequences of the dynamic adjustment for supply and demand proposed here, we present a graphical representation for each of the cases. Figures 4.5 to 4.7 present how this dynamic adjustment takes place, considering different parameter values.

We present nine possible cases. In all cases, the economy is in equilibrium when world growth (z) is equal to 4%. In order to simulate a positive external demand shock we consider $z = 5\%$.[14]

The first group of simulations, presented in Figure 4.5, consider that only the Verdoorn coefficient is endogenous to capacity utilization, as proposed by Setterfield (2006). The three cases in this group differentiate themselves for considering distinct labour supply curves. The blue one considers that labour supply is exogenous (Palley-Setterfield's assumption), the black one considers that labour supply is completely endogenous to its demand (McCombie's assumption), and the red one considers an intermediate case, where it is not exogenous but do not adjusts perfectly to accommodate its demand.

Figure 4.5 –Verdoorn coefficient as the only variable endogenous to capacity utilization for different labour supply adjustments

Output dynamics | Labour dynamics



Dashed lines: natural rate of growth (left) and growth of labour supply (right); solid lines: actual growth rate (left) and effectively employed labour growth (right). Blue lines: exogenous labour supply; black lines: completely endogenous labour supply; red line: intermediate case.

As can be seen from the left-hand side of Figure 4.5, output growth is *fully-demand determined* in all cases, as suggested before. The natural rate of growth always converge to the actual growth rate (but in a different paths). In McCombie's (2011) case (black line), where labour demand accommodates labour supply, the adjustment is instantaneous. Thereby we cannot see the black dashed line (which represents the natural growth rate) as it is equal to the solid line (which represents the actual growth). However, as the labour supply became less endogenous (blue line) as the time necessary for the adjustment increases.

[14] The simulations use the following parameters for all cases: $\varepsilon = 1.5$, $\lambda = 0$, $z = 0.05$. In the first group, $\pi_0 = 1.5$, $\pi_1 = 0$, $v_0 = 0$, $v_1 = 1$; in the second group, $\pi_0 = 1$, $\pi_1 = 1$, $v_0 = 0.5$, $v_1 = 0$; in the third group, $\pi_0 = 1$, $\pi_1 = 1$, $v_0 = 0$, $v_1 = 1$. Within the groups, the following variables are different for the labour supply: in black, $\gamma = 0$, $\delta = 0.5$; in blue, $\gamma = 0.02$, $\delta = 0$; in red, $\gamma = 0.01$, $\delta = 0.25$.

The adjustment process can be seen in the labour market dynamics (right-hand side): in McCombie's (2011) case, represented by the black line, labour supply growth is always equal to labour effectively employed growth, and thus there the solid and the dashed lines are coincident. Conversely, if labour supply is exogenous, a demand shock increases labour effectively employed growth, but, as Verdoorn coefficient, increases, employment growth reduces to adjust towards labour supply growth. Not surprisingly, the intermediate case (in red) provides a halfway adjustment: the demand shock will increase labour demand and labour supply, but the effect in the first is higher than in the second. However, as time passes, since actual output growth does not change (all adjustment is in the Verdoorn coefficient), employment growth decreases and adjusts towards the new labour supply growth rate.

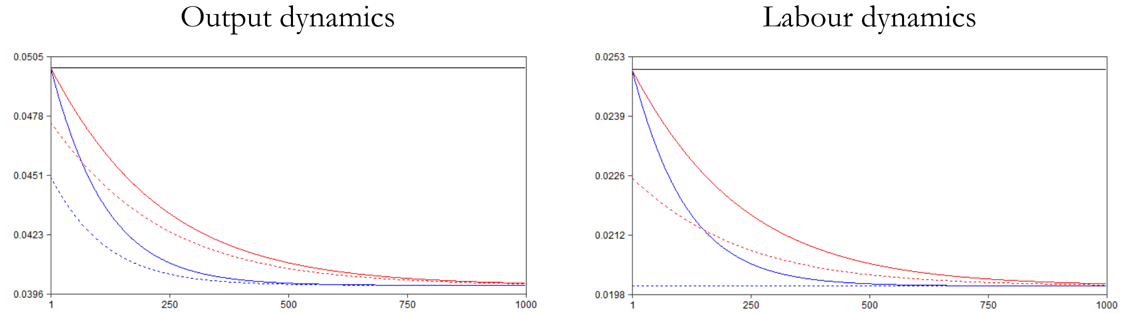
Results become more interesting (and less predictable) when there is an adjustment in income elasticity of demand for imports, as suggested by Palley (2003). If one assumes that the Verdoorn coefficient is not endogenous, but we may face with different labour supply schedules, growth can be either *fully-supply* or *fully-demand determined*. As can be seen from Figure 4.6, if one assumes that labour supply is completely endogenous to its demand (McCombie's assumption), growth is fully-demand determined, since labour supply adjusts instantaneously to it demand, and there is no change in capacity utilization.

In the case of labour supply being not perfectly endogenous (even in intermediate cases), growth in the long run is fully-supply determined. In the other extreme case, where it is exogenous, one could expect this result, since the labour effectively employed growth will have to adjust to labour supply growth as the only adjustment mechanism is the income elasticity, and hence the actual growth rate. Labour effectively employed adjusts towards its supply (which is given), and the economy returns to an equilibrium where the actual growth is independent of demand dynamics.

The intermediate case, however, is the most interesting, bringing new elements to the debate. A demand shock increases both the actual and the natural rate of growth. However, the actual growth rate will be higher than the natural growth rate, once the Verdoorn coefficient is lower than one (the impact of y on y_N is lower than the unity). Labour supply growth is also lower than labour effectively employed, as the adjustment is not complete. This causes employment rate (capacity utilization) to increase, and, consequently, raises the income-elasticity of demand. As a consequence, actual growth rate will decrease, reducing both labour effectively employed and labour supply growth rates. In the long run, when the new equilibrium is reached, growth rate returns to its original state (before the demand shock), which means that the economy is *fully-supply determined* even though labour supply is endogenous.

It is central to observe the time (speed) of the adjustment. The adjustment can take years (many time periods). Moreover, since it takes so long for the adjustment takes place; one could expect that a hysteresis effects could emerge, and the supply side of the economy to be permanently affected. A possible impact is an increase in R&D investments and other aspects, changing the exogenous technological change, λ, or the elasticity of labour supply to output (δ), which means that growth can be demand determined in the long run.

Figure 4.6 –Import elasticity as the only endogenous variable to capacity utilization for different labour supply adjustments



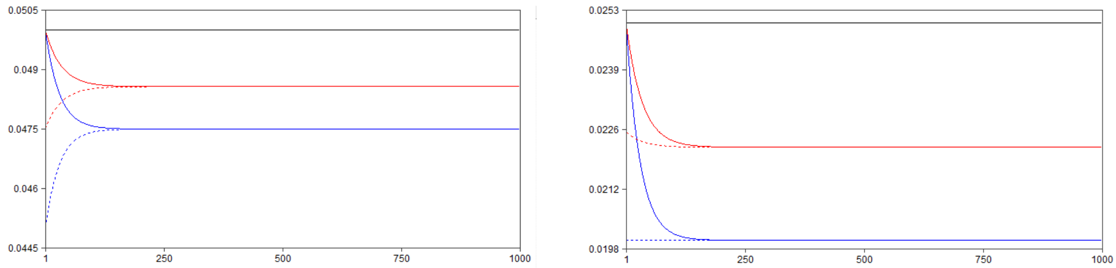
Dashed lines: natural rate of growth (left) and growth of labour supply (right); solid lines: actual growth rate (left) and effectively employed labour growth (right). Blue lines: exogenous labour supply; black lines: completely endogenous labour supply; red line: intermediate case.

Finally, the last group we simulate is the one in which both the Verdoorn coefficient and the income elasticity of demand for imports are endogenous to capacity utilization (Figure 4.7). The left-hand graph shows that growth can be fully-demand or partially demand-partially supply determined, depending on parameters. In the extreme case, where McCombie's (2011) adjustment takes place (labour supply is completely endogenous), growth is fully demand-determined, as in all other groups of cases. Conversely, when labour supply is completely exogenous, convergence occurs in an intermediate case, where both demand and supply forces are relevant to explain growth dynamics. In this case, labour supply growth is given, and labour demand adjusts towards it. However, during this process, employment rate (or rate of capacity utilization) rises and both the Verdoorn coefficient and the income elasticity of demand for imports also increases. Consequently, the actual and the natural growth move in opposite directions. The actual growth rate, which had grown due to demand shock, is reduced, whilst the natural growth rate, which had also grown but less than the actual growth rate, increases. In this sense, they will converge to an intermediate case.

The red lines in the right-hand side graph show that a positive shock on demand increases the labour supply, but it is not enough to reach the labour effectively employed. Therefore, employment rate will increase, as well as the Verdoorn coefficient and the import elasticity. This movement has negative impacts on the actual growth rate, and, consequently, labour supply decreases. Labour effectively employed decreases, since Verdoorn is increasing and demand is decreasing. However, it will decrease faster than labour supply growth rate, resulting in convergence. The left-hand graph shows that actual and natural growth rates converge to a higher level than the case where labour supply is exogenous. Growth is then *partially-demand* and *partially-supply* determined. Moreover, the faster the labour supply adjusts to its demand, more growth is demand determined.

Figure 4.7 –Both the Verdoorn and the import elasticity as endogenous variables to capacity utilization for different labour supply adjustments

Output dynamics | Labour dynamics



Dashed lines: natural rate of growth (left) and growth of labour supply (right); solid lines: actual growth rate (left) and effectively employed labour growth (right). Blue lines: exogenous labour supply; black lines: completely endogenous labour supply; red line: intermediate case.

The value of δ, which measures the labour supply elasticity to output, is a key variable on understanding whether growth is demand or supply determined, such as presented by McCombie (2011) and Setterfield (2013). However, only looking at this variable is not enough to understand the dynamics of supply and demand. With the aim of understanding the dynamic adjustment of actual and natural growth rates, we also need to consider the adjustment issues discussed by Palley (2003) and Setterfield (2006). If labour supply does not adjust completely to its demand, different results emerge from distinct adjustments of the Verdoorn coefficient and the income elasticity of demand for imports. These results are heterogenous not only in terms of the stable equilibrium, but also in terms of the time (speed) needed to reach it.

These three classes of cases summarize each of the possible adjustments we present in the debate. This contributes to the literature, showing different cases for the reconciliation of the debate about the convergence between supply and demand growth rates.

5. Conclusion

In this paper we present the state of the current debate in terms of the convergence between supply and demand in Kaldorian models. We raise the literature on the different adjustment propositions between the natural rate of growth and the effective rate based on the Palley (2003) and Setterfield (2006) debate, followed by McCombie's (2011) critique. We follow the response by Setterfield (2013), and his considerations on growth adjustments under capital and labour constraints. Our contribution accept the vision on labour constraints, but proposes a critique to Setterfield (2013) in terms of capital constraints, showing that there is no need for reconciliation if firms invest to keep the rate of capital utilization unchanged. However, Setterfield's (2013) discussion on labour constraints brings some important issues to the debate, and hence the need for reconciliation, modelling the labour market.

Our contribution goes in accordance with the classical argument of Cornwall (1977), summarised by McCombie and Thirlwall (1994), to whom it is central to analyse not only developing economies, but also advanced economies as "dual economies". In this sense, the growth of labour supply responds to the growth of wages and output, instead of being exogenously given.

In order to reconciliate the different perspectives, we analyse the adjustment on employment through the dynamic behaviour of labour supply and effective labour. We propose an interpretation of the labour market, following Setterfield (2013), proposing a general model capable of summarizing the Palley-Setterfield (Palley, 2003; Setterfield, 2006) and the McCombie (2011) perspectives, understood as extreme cases of the same general model. This is an initial approach that shows that the faster labour supply adjusts to changes in economic growth (and to labour demand), the closer we leave a Palley-Setterfiled's result towards the McCombie's result. Our model allows us to reproduce intermediate results, based on the speed in which the two growth rates adjust.

From simulations we found that growth is always *fully-demand determined* when (1) labour supply is completely endogenous to its demand or (2) if there is no adjustment in income elasticities of import. However, the adjustment processes occurs differently in each of these cases. In the case of completely endogenous labour supply, all adjustment occur in n. In the case of exogenous labour supply all adjustment happens on the Verdoorn coefficient (v). In the intermediate case both variables n and v adjust for the natural growth rates to adjust towards the actual growth rate.

Interesting results emerge when the income elasticity of demand for imports (π) is endogenous. If it is the case and the Verdoorn coefficient is not sensitive to capacity utilization, growth is only *fully-demand determined* if labour supply is completely endogenous to its demand. In all the other cases, growth is *fully-supply determined* in the long run. This result, however, cannot be interpreted without considering the time required for the adjustment. The higher is the sensibility of labour supply to output, the slower is the adjustment. If one considers the parameters used in our simulation, the convergence can take a very long time period. Thereby, one cannot ignore that supply can change substantially during the adjustment process. If, for example, higher actual growth rates increase investment in R&D, other variables can adjust, such as the exogenous technological progress (λ).

Another important result arises when both the Verdoorn coefficient and the import elasticities are endogenous to capacity utilization. The higher is the sensibility of labour supply to output, the more the economy is demand determined. With exogenous labour supply, the economy is *partially-supply* and *partially-demand determined*; and with completely endogenous labour supply growth, it is *fully-demand determined*. In a contrast to the case mentioned in the last paragraph, for the intermediate case, it is not the time necessary for the adjustment that changes, but the long-run growth rate. The closer to a complete endogenous labour supply, the higher share of growth is demand determined.

Finally, the baseline model that we propose in this article opens the possibility of different types of expansions, such as endogenizing technological progress through the variable λ; adding structural change, through changes in the income elasticity ratio and in the Verdoorn coefficient; supply shocks and demand shocks, such as a foreign crisis (reducing international demand).

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List of Variables

y	Effective growth rate	ε	Income elasticity of demand for exports
y_B	BOP Constrained Growth Rate	π	Income elasticity of demand for imports
y_N	Natural growth rate	π_0	Autonomous part of the income elasticity of demand for imports
E	Employment level	π_1	Sensitivity of the BOP constrained growth rate to the rate of capacity utilization.
e	Employment growth rate	z	Foreign GDP growth rate
N	Total labor supply	v	Kaldor-Verdoorn coefficient
n	Growth of labor supply	v_0	Autonomous part of the Kaldor-Verdoorn coefficient.
L	Total labor demand	v_1	Sensitivity of the Kaldor-Verdoorn coefficient to the rate of capacity utilization.
l	Growth of labor demand	λ	Autonomous productivity growth
δ	Labor-elasticity to output	γ	Exogenous growth of labor
a	Labor-output ratio	b	Capital-output ratio

Appendix A. Mathematical derivation of the general model

Growth Rates

The demand rate is given by the Thirlwall Law:

$$y_B = \frac{\varepsilon}{\pi_0 + \pi_1 E} z \tag{B.1}$$

The supply rate is given by the supply constrains ($y^N = n + q$):

$$y_N = n + \lambda + (v_0 + v_1 E)y \tag{B.2}$$

Labour Market

The effective labour is given by the supply condition under the effective growth rate ($l = q - y$):

$$l = -\lambda + (1 - v_0 - v_1 E)y \tag{B.3}$$

The labour supply is given by an exogenous parameter and sensitiveness to effective growth:

$$n = \gamma + \delta y \tag{B.4}$$

Adjustment

Replacing C.4 in C.2 we have that

$$y_N = \gamma + \delta y + \lambda + (v_0 + v_1 E)y \tag{B.5}$$

As $e = \frac{\dot{E}}{E}$ and $e = l - n$:

$$\dot{E} = E[(1 - v_0 - v_1 E)y - \lambda - \gamma - \delta y] \tag{B.6}$$

Defining that effective growth rate is given by demand ($\boldsymbol{y} = \boldsymbol{y_B}$), then:

$$\dot{E} = E\left[(1 - v_0 - v_1 E)\frac{\varepsilon}{\pi_0 + \pi_1 E} z - \lambda - \gamma - \delta \frac{\varepsilon}{\pi_0 + \pi_1 E} z\right] \tag{B.7}$$

Calculating the steady state ($\dot{E} = 0$):

$$E^* = \frac{(1 - v_0)\,\varepsilon z - \delta \varepsilon z - (\lambda + \gamma)\pi_0}{(\lambda \pi_1 + \gamma \pi_1 + v_1 \varepsilon z)} \tag{B.8}$$

For the stability condition $\left(\frac{\partial \dot{E}}{\partial E} < 0\right)$

$$\delta < 1 - v \tag{B.9}$$